CLAIMS

1. A transformant of an organism producing a secondary metabolite having a benzene ring skeleton that is not substituted with a functional group containing a nitrogen atom at the para-position, wherein the transformant is transformed by introducing a gene involved in a biosynthetic pathway from chorismic acid to p-aminophenylpyruvic acid (biosynthesis gene) so that the transformant produces a secondary metabolite having a benzene ring skeleton substituted at the para-position with a functional group containing a nitrogen atom.

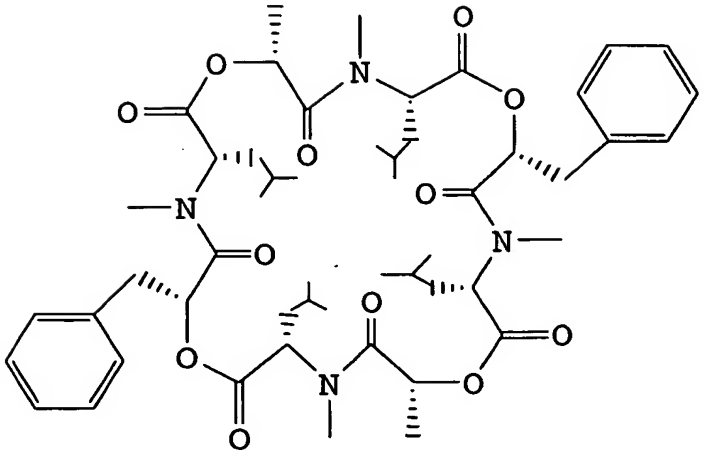
2. The transformant according to claim 1, wherein the organism to be transformed is an organism that produces a secondary metabolite biosynthesized via chorismic acid.

3. The transformant according to claim 2, wherein the secondary metabolite biosynthesized via chorismic acid is synthesized from at least one building block selected from the group consisting of phenylpyruvic acid, p-hydroxyphenyllactic acid, phenylalanine, tyrosine, and phenyllactic acid.

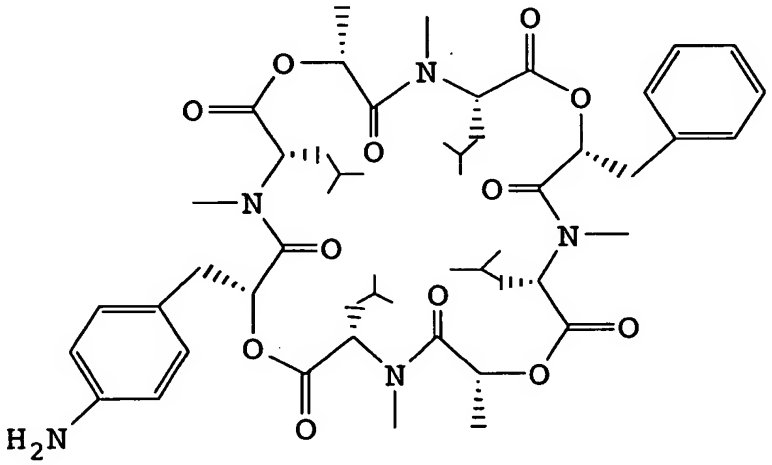
4. The transformant according to claim 1, wherein the organism to be transformed is an organism that produces a peptide or a depsipeptide as a secondary metabolite.

5. The transformant according to claim 4, wherein the peptide or the depsipeptide is synthesized from at least one building block selected from the group consisting of phenylalanine, tyrosine, and phenyllactic acid.

6. The transformant according to claim 1, wherein the organism to be transformed is a microorganism that produces a compound of the following formula.



7. The transformant according to claim 6, wherein the secondary metabolite produced by the transformant is a compound of the following formula.



8. The transformant according to any one of claims 1 to 7, wherein the biosynthesis gene comprises a gene encoding 4-amino-4-deoxychorismic acid synthase, a gene encoding 4-amino-4-deoxychorismic acid mutase, and a gene encoding 4-amino-4-deoxyprephenic acid dehydrogenase.

9. The transformant according to claim 8, wherein at least one in the biosynthesis gene comprising a gene encoding 4-amino-4-deoxychorismic acid-synthesizing enzyme, a gene encoding 4-amino-4-deoxychorismic acid mutase, and a gene encoding 4-amino-4-deoxyprephenic acid dehydrogenase is a gene from genus Streptomyces, genus Nocardia, or genus Corynebacterium.

10. The transformant according to claim 8 or 9, wherein

the gene encoding 4-amino-4-deoxychorismic acid synthase comprises a polynucleotide encoding the amino acid sequence of SEQ ID NO: 2 or a modified sequence of SEQ ID NO:2 having 4-amino-4-deoxychorismic acid synthase activity.

11. The transformant according to claim 8, 9 or 10, wherein the gene encoding 4-amino-4-deoxychorismic acid synthase comprises the DNA sequence of SEQ ID NO: 1.

12. The transformant according to claim 8 or 9, wherein the gene encoding 4-amino-4-deoxychorismic acid mutase comprises a polynucleotide encoding the amino acid sequence of SEQ ID NO: 4 or a modified sequence of SEQ ID NO: 4 having 4-amino-4-deoxychorismic acid mutase activity.

13. The transformant according to claim 8, 9 or 12, wherein the gene encoding 4-amino-4-deoxychorismic acid mutase comprises the DNA sequence of SEQ ID NO: 3.

14. The transformant according to claim 8 or 9, wherein the gene encoding 4-amino-4-deoxyprephenic acid dehydrogenase comprises a polynucleotide encoding the amino acid sequence of SEQ ID NO: 6 or a modified sequence of SEQ ID NO: 6 having 4-amino-4-deoxyprephenic acid dehydrogenase activity.

15. The transformant according to claim 8, 9 or 14, wherein the gene encoding 4-amino-4-deoxyprephenic acid dehydrogenase comprises the DNA sequence of SEQ ID NO: 5.

16. The transformant according to claim 8 or 9, wherein the gene encoding 4-amino-4-deoxychorismic acid synthase, the gene encoding 4-amino-4-deoxychorismic acid mutase, and the gene encoding 4-amino-4-deoxyprephenic acid dehydrogenase comprise a polynucleotide encoding the amino acid sequence of SEQ ID NO: 2 or a modified sequence of SEQ ID NO: 2 having 4-amino-4-deoxychorismic acid synthase activity, a polynucleotide encoding the amino acid sequence of SEQ ID NO: 4 or a modified sequence of SEQ ID NO: 4 having 4-amino-4-deoxychorismic acid mutase activity, and a polynucleotide encoding the amino acid sequence of SEQ ID NO: 6 or a modified sequence of SEQ ID NO: 6 having 4-amino-4-deoxyprephenic acid dehydrogenase activity, respectively.

17. The transformant according to claim 8, 9 or 16, wherein

the gene encoding 4-amino-4-deoxychorismic acid synthase, the gene encoding 4-amino-4-deoxychorismic acid mutase, and the gene encoding 4-amino-4-deoxyprephenic acid dehydrogenase comprise the DNA sequence of SEQ ID NO: 1, the DNA sequence of SEQ ID NO: 3, and the DNA sequence of SEQ ID NO: 5, respectively.

18. The transformant according to any one of claims 1 to 17, wherein the organism to be transformed is a microorganism.

19. The transformant according to claim 18, wherein the microorganism is Mycelia sterilia.

20. The transformant according to claim 19, wherein Mycelia sterilia is a strain PF1022 deposited with the National Institute of Bioscience and Human-Technology under an accession number of FERM BP-2671.

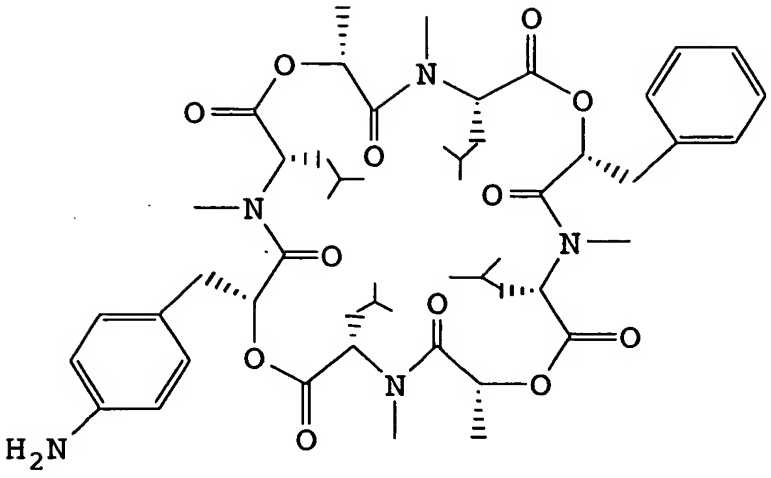
21. The transformant according to any one of claims 1 to 20, wherein the transformant is strain 55-65 deposited with the National Institute of Bioscience and Human-Technology under an accession number of FERM BP-7255.

22. The transformant according to any one of claims 1 to 17, wherein the organism to be transformed is a plant.

23. A method for producing a secondary metabolite having a benzene ring skeleton substituted at the para-position with a functional group containing a nitrogen atom, which comprises the steps of culturing the transformant of any one of claims 1 to 22 and collecting the secondary metabolite having a benzene ring skeleton substituted at the para-position with a functional group containing a nitrogen atom.

24. The method according to claim 23, wherein the functional group containing a nitrogen atom is a nitro group or amino group.

25. A method for producing a substance PF1022 derivative, which comprises the steps of culturing the transformant of claim 6, 19, 20 or 21 and collecting the substance PF1022 derivative of the following formula.



26. A polynucleotide encoding the amino acid sequence of SEQ ID NO: 2 or a modified sequence of SEQ ID NO: 2 having 4-amino-4-deoxychorismic acid synthase activity.

27. The polynucleotide according to claim 26, which comprises the DNA sequence of SEQ ID NO: 1.

28. A polynucleotide encoding the amino acid sequence of SEQ ID NO: 4 or a modified sequence of SEQ ID NO: 4 having 4-amino-4-deoxychorismic acid mutase activity.

29. The polynucleotide according to claim 28, which comprises the DNA sequence of SEQ ID NO: 3.

30. A polynucleotide encoding the amino acid sequence of SEQ ID NO: 6 or a modified sequence of SEQ ID NO: 6 having 4-amino-4-deoxyprephenic acid dehydrogenase activity.

31. The polynucleotide according to claim 30, which comprises the DNA sequence of SEQ ID NO: 5.